

Quantum computing and artificial intelligence: a synergy for the future

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Abstract. One of the promising technologies that we will have in the nearest future is related to quantum mechanics. With the powerful tool such as artificial intelligence that we have right now, it is hard to imagine what it will become with the new technology. Quantum computing is one of the promising technologies that will further elevate various areas. This article delves into the basics of this technology and its use with artificial intelligence. The two technologies are capable of unimaginable changes in our world. The possible advantages of the two technologies will be covered in this article. Some drawbacks that they will bring with them are also covered.

1 Introduction

Lately, two of the ground-breaking fields are penetrating the world of technology. These two technologies will drastically change the well-established world we know. The first one is quantum computing, and the other one is artificial intelligence. Both of these technologies are able to reshape our industries and solve complex and challenging problems. It is also important to note the differences between the two technologies for better understanding of their capabilities. Some believe that quantum computing will replace artificial intelligence and become the superior technology. In reality, both of them are quite different in terms of handling tasks. It is obvious that they will work best hand in hand if they reach a level where both are capable of achieving what they promise. Artificial intelligence acts as a human brain that allows other technologies to perform such tasks as thinking, learning, adapting, and so on, while quantum computing is a technology that computes data in an unimaginable way but has nothing to do with its analysis, classification, interpretation, etc. It is also a known fact that quantum computing is still in the process of becoming a complete technology capable of performing as promised. However, artificial intelligence is well-adapted in various fields and is used as the main driver of any process it is involved in.

Both technologies can individually work on leveling various areas such as healthcare, finance, materials science, cybersecurity, and others. However, when combined together, they can increase their capabilities and potential to an unprecedented level. The simplest promise of these technologies is that each of them will accelerate the other, hence increasing

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their capabilities. Therefore, quantum computing will act as a catalyst for artificial intelligence.

The following article will explore how the interaction of these two technologies, quantum computing and artificial intelligence, will reshape the landscape of innovation. The idea behind quantum computing, its influence on artificial intelligence, and their impact on others will be explained in this article [1, 2].

2 Quantum computing and artificial intelligence

2.1 Artificial intelligence

Artificial intelligence, without any further improvement, is at its finest state. Its capabilities are driving various industries to a new level, achieving trajectories of improvement they never imagined reaching at this speed. However, with other technological breakthroughs, artificial intelligence can grow beyond any imagination. Right now, the push for artificial intelligence comes from the advancement of algorithms and the increase in computational power. Each day, new algorithms are developed for various tasks, and each day, they are refined for better performance and outcomes. The second accelerator of the technology is the power to calculate all the processes created by these algorithms. To achieve better calculations in this field, quantum computing can be utilized [3].

2.2 Quantum computing

This cutting-edge field of computing uses principles from quantum mechanics. Quantum mechanics is a fundamental theory in physics that describes nature at the smallest scales. When saying smallest, it refers to atoms and beyond them, including subatomic particles. There is great dissimilarity between the two computing technologies. In the first case, classical computers process information in binary (0s and 1s). In the case of quantum computers, quantum bits or qubits are used to process information. A qubit or quantum bit is the basic unit of information in quantum computing. A qubit is similar to a binary system, but it behaves much differently because of the quantum properties on which it's based. In simplest terms, a qubit can represent a 0, a 1, or both at the same time, which is referred to as superposition (the ability of a quantum system to be in multiple states at the same time until it is measured), enabling quantum computers to perform many calculations simultaneously [4,5,6].

Table 1. Quantum vs. Classical Computing

Feature	Classical Computing	Quantum Computing
Unit of Information	Bit (0 or 1)	Qubit (0, 1, or both)
Computation Model	Deterministic	Probabilistic
Parallel Processing	Limited	Intrinsic (superposition)
Key Strengths	General-purpose tasks	Specific complex tasks

3 Advantages of quantum computing

The advantages of artificial intelligence and quantum computing are vast. With their combination, many issues will be solved. They will revolutionize the world we live in. Many new technologies will occur due to their power and capabilities. Some of the major advantages are presented below. These advantages are those that can be easily predicted by

analyzing the present state. However, there will be some novel solutions, ideas, and technologies that are hard to predict (Figure 1) [7, 8].

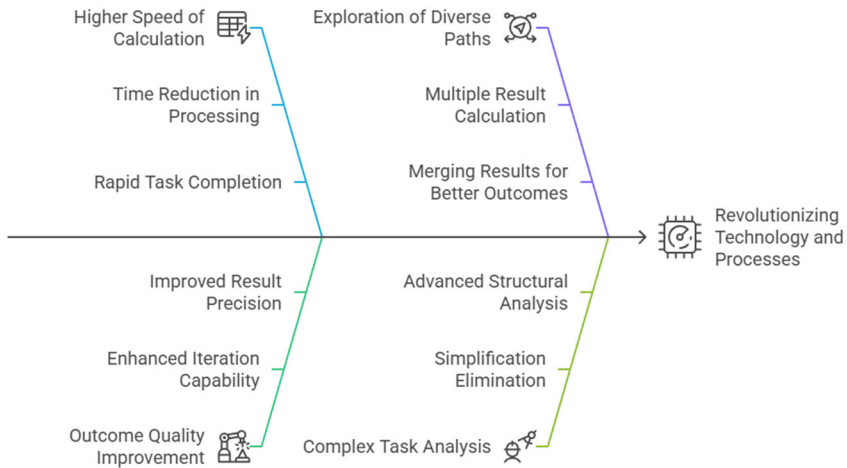


Fig. 1. Advantages of Quantum Computing in AI.

3.1 Higher speed of calculation

The major introduction of quantum computing to artificial intelligence is the higher speed of calculation. For any industry, time is a valuable asset, and thus its minimization in various processes is considered advantageous and beneficial. With the use of quantum computing and artificial intelligence, the time of processing will drop to almost zero in some processes. Any task that involves calculation will be done in a second. However, one must understand that the processes described in this work are those available at the moment. With the occurrence of quantum computing in artificial intelligence and in the nearest future, new technologies must occur that require more computational power than what we have right now [9].

3.2 Outcome quality improvement

Outcome quality increase is something that quantum computing can provide. The end results in most cases depend on the iterations. For higher results and precision, more iterations are required. Although there are some constraints for these paths of calculations. For instance, most of them are stopped as they reach a convenient and reasonable state, as further iterations could give an unnoticeable change to the end result. Although with the occurrence of technology that can go beyond the norms, some changes might be introduced [10].

3.3 Exploration of diverse paths

Various different paths can be one of the advantages of the combination of these two technologies. Modern tools are capable of reaching a certain result, but most of the time they lack some aspects. With the powerful tool for calculation, various results can be calculated and merged together for a better outcome.

3.4 Complex task analysis in engineering and beyond

Complex task analysis in the engineering world and beyond is another advantage. For instance, to calculate a structure under various conditions, some idealization steps are taken. This means that the structure is simplified to lessen the time of calculation and its complexity. With the occurrence of quantum computing, there will be no need for the simplification and other manipulations with the structure in favor of easing the overall process.

4 Challenges of the technology

It is true that the combination of quantum computing and artificial intelligence can benefit various fields, but there are some challenges that need to be addressed before they reach their full potential (Figure 2).

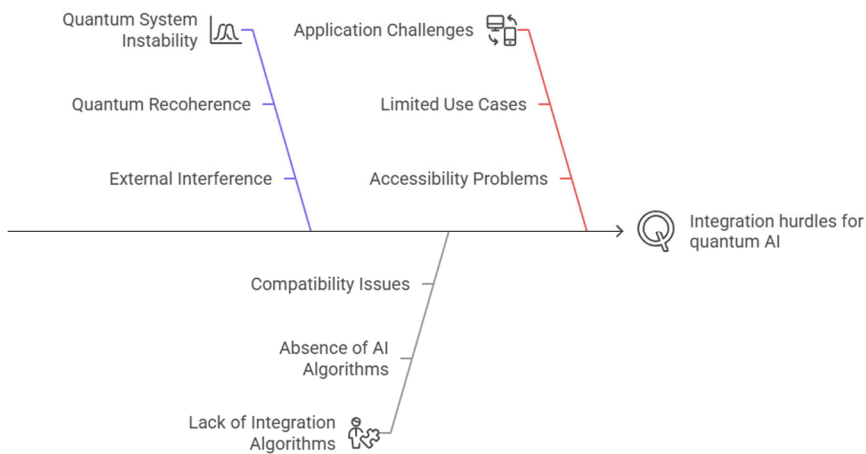


Fig. 2. Challenges in Integrating Quantum Computing with AI.

One major issue with quantum computing is the instability of quantum systems. The phenomenon is called quantum decoherence. This phenomenon occurs due to external factors such as temperature and electromagnetic interference. These factors lead to errors in calculations. The second issue is related to the combination itself. Even if we have a ready quantum computing system, there are no algorithms that will integrate artificial intelligence into the technology. The application and availability are other issues that are not directly connected to the technology [11-14].

5 Conclusion

The work looked into quantum computing and its possible advantages with artificial intelligence. Quantum computing is one of the most anticipated technologies that will drive various fields and areas to unbelievable heights. With the combination of these two technologies, the benefits are incalculable. This work briefly outlined both technologies and the possible advantages that they can bring to the table. Some of the disadvantages were also described in this work. It is obvious that this technology will have some challenges at the beginning. With the passage of time, the technology will drastically change the world we

know into a completely new appearance. The high cost and complexity of quantum computing hardware make it harder for various industries to apply them. A similar issue occurs with the energy requirement and the needed infrastructure. One of the other issues is related to the ethical side. Its possible superiority over humans raises some major questions as well.

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